



Application No. 10/624,921
App. Docket No. 2398-031312

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. : 10/624,921 Confirmation No.: 7119
Applicant : Mark A. Bernick
Filed : July 22, 2003
Title : **MOVING MAGNETIC/CATHODE ARRANGEMENT AND METHOD**
Art Unit : 1753
Examiner : Rodney Glenn McDonald
Customer No. : 28289

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION OF MARK A. BERNICK UNDER 37 C.F.R. § 1.132

Sir:

I, Mark A. Bernick, hereby declare as follows:

1. I am a citizen of the United States of America, and a resident of White Oak, PA. I have a Bachelor of Science degree in Physics from The University of Pittsburgh in Pittsburgh, Pennsylvania. I have over 25 years of experience in the field of magnetron technology. From 1988 until present, I have been president of Angstrom Sciences, Inc. where I have been engaged in magnetron research, product development, field services, engineering and corporate management.

2. I am familiar with the subject matter of the above-identified patent application, including the amended claims. The claimed magnetron sputtering electrode arrangement utilizes a closed magnet arrangement comprised of a plurality of profiled magnets adapted for motion relative to a target having an outer edge thus allowing for the coating of a substrate with a material sputtered from the target composed of the material. Each of the profiled magnets include a contoured top portion having an apex positioned

beneath a target, wherein the apex of at least one of the profiled magnets is positioned adjacent to the outer edge of the target, such that a portion of the contoured top portion of the profiled magnet is at or extends beyond the outer edge of the target. The prior art does not disclose any profiled magnets in a rotary magnetron having a portion of an apex positioned at or extending beyond an outer edge of a target or the new and unexpected results associated with such design.

3. The new and unexpected advantages associated with the use of profiled magnets in a rotary magnetron design as claimed extend beyond the known advantages associated with the use of these profiled magnets in non-rotary magnetron designs as disclosed in Exhibit A. For example, the use of profiled magnets in a non-rotary magnetron results in an increase in target utilization ranging from 30% to 40%, which is approximately a 20% increase from the prior art magnetron designs utilizing flat magnets. However, the use of profiled magnets in a rotary magnetron results in an increase in target utilization ranging from 50% to 60%, which is far beyond the expected benefit of profiled magnets used in non-rotary magnetrons.

4. The new and unexpected increase in target utilization is due to a number of factors, one of which is the reduction of “dark space” or non-active area on the target surface. For example, Fig. 1 of Exhibit B is an illustration of an erosion pattern of a target using flat magnets on a rotary magnetron design. Fig. 2 is an illustration of an erosion pattern of a target using the profiled magnets on a rotary magnetron design. As can be seen in Fig. 2, the dark space at the center of the target and at the ends are substantially smaller than the target shown in Fig. 1. Specifically, the position of the end magnets where a portion of the contoured top portion is at or extends slightly beyond the outer edge of the target maximizes the spreading of the magnetic field lines over the entire surface of the target, thus reducing the amount of the dark space, particularly at the ends of the target. Exhibit C shows two photographs of the erosion pattern of a target utilizing the claimed magnetron arrangement. As shown, the erosion pattern is close to the edge of the target.

5. The claimed magnetron arrangement also provides for a significant reduction in particulate contamination. Particulate contamination occurs primarily in the dark space wherein redeposition causes particles to flake off from the dark space and contaminate

the substrate. This reduction in dark space on the target translates into a reduction in the particulate contamination.

6. Other new and unexpected advantages associated with the use of profiled magnets on rotary magnetron designs include the use of smaller target sizes in contrast to the size of the target for equivalent prior art (i.e., flat magnets) rotary magnetron designs. For example, an 8" circular target used on the claimed magnetron arrangement can achieve substantially the same amount of deposition as a 10" circular target used in a prior art rotary magnetron arrangement. This results in a 36% reduction in target area which translates into less chamber volume, less floor space and decreased target cost.

7. Although it is known that the use of profiled magnets produce higher magnetics in non-rotary magnetron designs, the use of these profiled magnets in a rotary magnetron design resulted in either a 20% power reduction or a 20% increase in deposition rate in contrast to a comparable prior art rotary magnetron without profiled magnets. The power reduction translates into a 20% energy savings, and the increased rate translates into faster cycle times and higher pump speeds for the claimed magnetron arrangement. All of the above results far exceed any of the expected or known advantages associated with the use of profiled magnets in non-rotary magnetron designs.

8. The claimed magnetron arrangement in the above-referenced application has enjoyed commercial success, with little to no advertising expense (e.g., less than \$5,000.00). Up to the present, over 30 of the claimed magnetron designs have been sold to at least eight different customers in the past two (2) years. This represents over \$400,000 in sales. In all these cases, the claimed magnetron arrangements were purchased for the specific reason that they have a high target utilization, increased rate or energy savings because of the higher magnetics, decreased particulate contamination and reduced floor space compared to prior art rotary magnetron designs. Furthermore, the claimed rotary magnetrons are the only ones available in the marketplace.

9. As can be seen from the considerable number of units already sold, the number of customers and the low advertising expenditures, the present customers are attesting to the advantages of the claimed magnetron arrangement thereby contributing to the substantial sales and commercial success of the present invention.

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10. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under § 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.



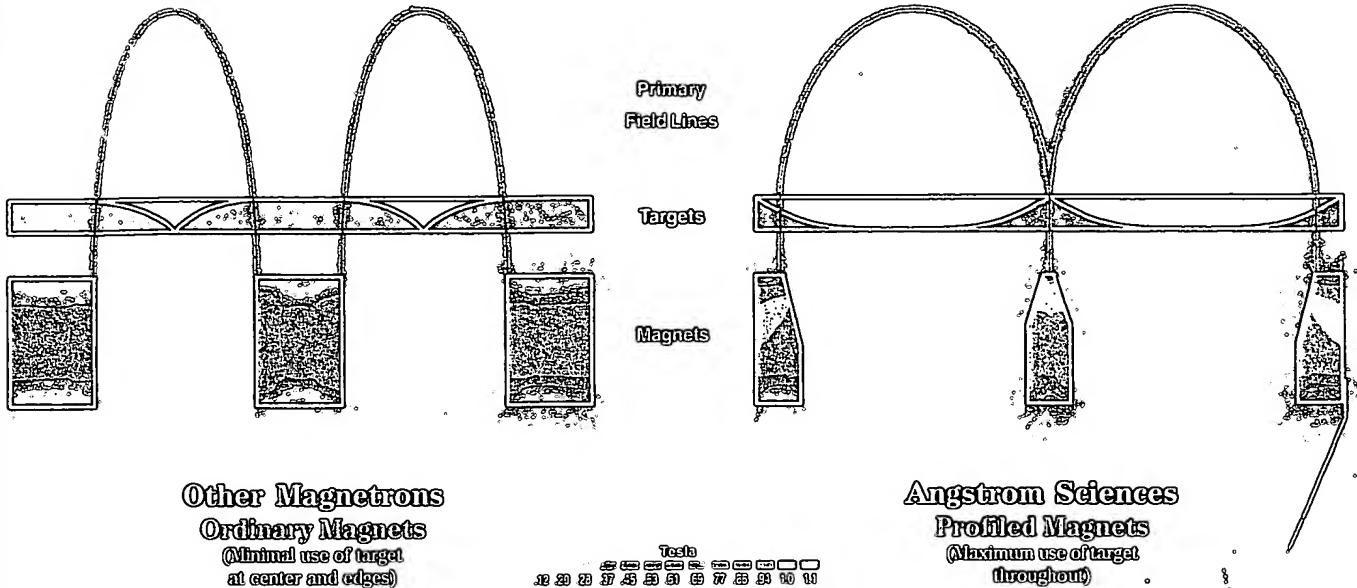
Mark A. Bernick

1-5-2006

(Date)

Exhibit A

The Advantage Of Profiled Magnets



Other Magnetrons
Ordinary Magnets
 (Minimal use of target
 at center and edges)

Angstrom Sciences
Profiled Magnets
 (Maximum use of target
 throughout)

The Angstrom Advantages

Greater Control

All reputable makers of magnetron sources use permanent rare-earth magnets to direct the flow of atoms during the sputtering process.

But that's where the similarity between their products and ours ends.

Because, to optimize performance for any application, you have to be able to control the *shape* of the magnetic field.

And even the most carefully calculated placement of conventional magnets can't do that as well as the advanced new method we've developed and patented.

Profiled Magnets

Simply put, we *profile* our magnets.

That is, we grind them into contours which optimize the shape of the *field* they generate. Because, the shape of that field determines everything from film uniformity and deposition rate to target utilization.

This approach allows us to use computer modeling to match your application with the magnetic profile that will work best for you. We can even custom-engineer magnetries to meet your specific requirements.*

Optimized Performance

The result is, you get exactly the kind of performance you need — whether it's high uniformity and target utilization, high rate and throughput, or a perfect balance between the two.

And you get that performance in a state-of-the-art device that provides many other advantages as well (including the option of balanced or unbalanced magnetron fields).

More Efficient Cooling

Turbulent water flow is another advance we've pioneered, patented, and built into every one of our magnetrons.

It's superior to old-fashioned laminar water flow because it distributes cooling more evenly across the cathode, to help minimize "hot spots" and eliminate both grain boundary dissociation and cracking of thermally sensitive materials.

Faster, Easier Target Change

Angstrom Sciences magnetrons also incorporate our patented threaded target clamping system, which helps minimize downtime by providing the fastest, easiest method available for changing targets (plus, it adjusts to variable target thickness without extra tools or devices).

Stronger Magnetrons & Magnets

Unlike most manufacturers, we machine each of our standard magnetrons out of solid blocks of 304 stainless steel and OFHC copper. And we use NiFeB magnets — which are 30% more powerful than other rare-earth magnets. So you can count on getting maximum magnetic integrity, encased in the most robust precision-fitted assembly you can buy.

More Comprehensive Service

Angstrom Sciences designs, engineers, and manufactures a complete line of sputtering sources for everything from research and development to full-scale production applications.

And we offer a comprehensive array of targets, evaporation materials, backing plates, and bonding techniques, too.

But we also pride ourselves on the ability to rise to any occasion. So if you don't find what you're looking for in our literature, please don't hesitate to call.

We'll be happy to work with you, to help you incorporate the latest advances in magnetron technology into your own sputtering applications.

Note: Some manufacturers try to achieve similar results by installing *secondary* magnets to alter the shape of the field. That method not only costs more to manufacture, but provides less stability than profiling, and generates stray field lines with undue uniformity.

rectangular magnetrons

Expanding Horizons

As more and more industries discover the speed, controllability, and bottom-line benefits of magnetron sputtering, production professionals are reaching out for ways to apply these advantages to larger, faster manufacturing processes.

Broader Solutions

For many, particularly those who have to coat broad physical substrates or achieve extremely high throughput, rectangular magnetrons offer the perfect solution.

Growing Applications

That's why use of rectangular magnetrons is growing so rapidly in industries such as:

- Aerospace
- Architectural Glass
- Authentication
- Automotive
- Decorative Coating
- Defense
- Flat Panel Displays
- Magnetic Storage Media
- Medical/Dental
- Optical
- Packaging
- Semiconductors/Microelectronics
- Solar
- Wear-Resistant Coating

**New
Capacity
For
Production**

Shaping The Future

And that's also why Angstrom Sciences is reshaping the future of sputtering technology with a complete line of rectangular magnetrons for every application.

Examples Of 4" Wide Rectangular Target Erosion



Angstrom Sciences Magnetron



Ordinary Magnetron

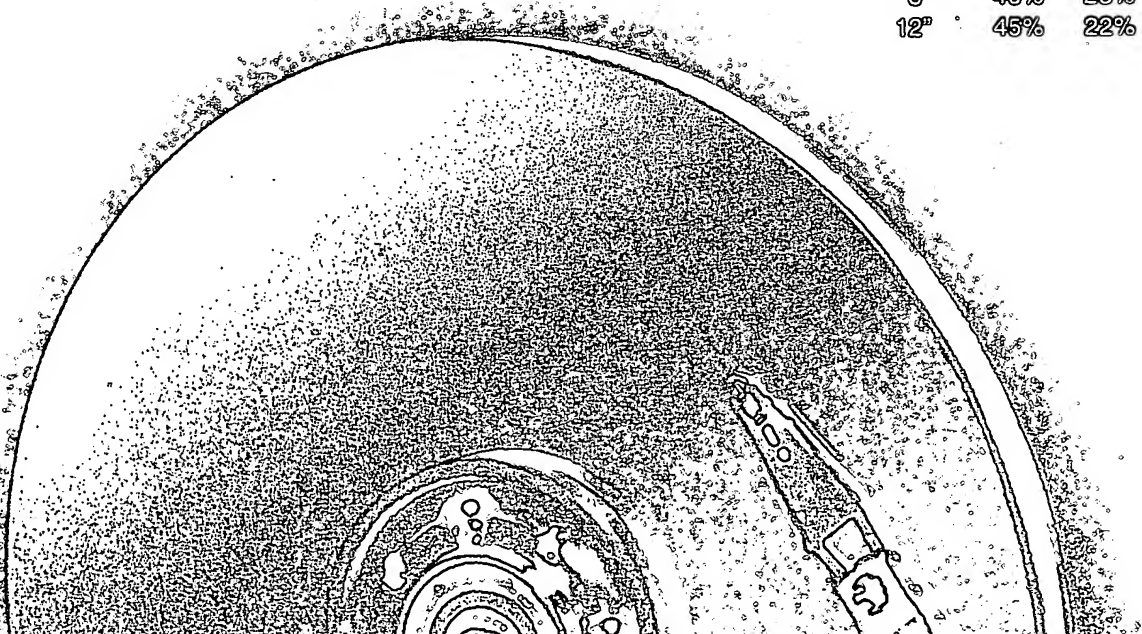
Patented Advantages

Just like our circular magnetrons, Angstrom Sciences rectangular magnetrons incorporate our patented profiled magnets, turbulent water flow, solid stainless steel construction, and fully-encased NdFeB rare earth magnets.

And, naturally, they also feature industry-standard fittings, total power-supply compatibility, and internal and external mounting options.

Rectangular Magnetron Performance*

TARGET WIDTH	UTILIZATION		
	ANGSTROM SCIENCES	OTHER DESIGNS	UNIFORMITY
1.5"	43%	—	±5%
3.5"	44%	22%	±5%
4"	46%	21%	±5%
5"	47%	22%	±5%
6"	47%	23%	±5%
8"	46%	23%	±5%
12"	45%	22%	±5%



The New Standard Of The Industry

More Advanced, and More Efficient

Angstrom Sciences circular magnetrons have become recognized as the new standard of the sputtering industry.

Because in addition to their advanced features — such as profiled magnets, turbulent water flow, and solid stainless steel construction — they offer a host of other performance advantages as well.

Examples Of 8" Circular Target Erosion



Angstrom Sciences Magnetron



Ordinary Magnetron

Versatile, Compact Design

Their ultra-compact design makes them ideal for virtually any new or retrofit application — including the most complex multiple-cathode deposition clusters or the smallest vacuum chambers. And they are available configured for either internal or external mounts.

Total Power Compatibility

Their low-impedance heads provide RF, DC, mid-frequency DC, pulsed DC, and microwave power compatibility.

Standard Fittings

Angstrom Sciences uses ISO NW standard fittings, as well as ConFlat® metal seal flanges. All utilities are maintained at atmosphere, and are accessed through standard "O"-ring compression fittings for ease of installation in any vacuum system.

Full Range Of Sizes

Angstrom Sciences circular magnetron sources are available in 1", 2", 3", 4", 5", 6", 8", 10", 12", and 16" target sizes.

Quick, Easy Target Change

Our patented threaded clamp and anode shield allow you to change targets (sizes 1" to 6") quickly and easily without specialized tools. And their built-in adjustability lets you fit targets of varying thickness without resorting to spacing devices.

Lower Pressure, Higher Power

Our cathodes can operate at extremely low pressure — down to the 10^{-4} Torr range — and our directly-cooled designs can deliver power densities up to 250 watts/in² (39 watts/cm²).

Higher Rates And Performance

That means you can coat a substrate faster with Angstrom Sciences magnetrons.

So you can maximize both your coating zone and your target utilization without the kind of trade-off in rate that other magnetrons force you to make.

Greater Target Utilization

Yet these same advanced magnetrons can give you target utilization typically in the range of 40%.

Greater Uniformity

And, thanks to our patented profiled magnets, our magnetrons also deliver much greater uniformity of deposition — routinely in the ± 3 -to-5% range.

(One of our research customers has even documented uniformity of $\pm .1\%$ with Angstrom Sciences magnetrons.)

Exhibit B

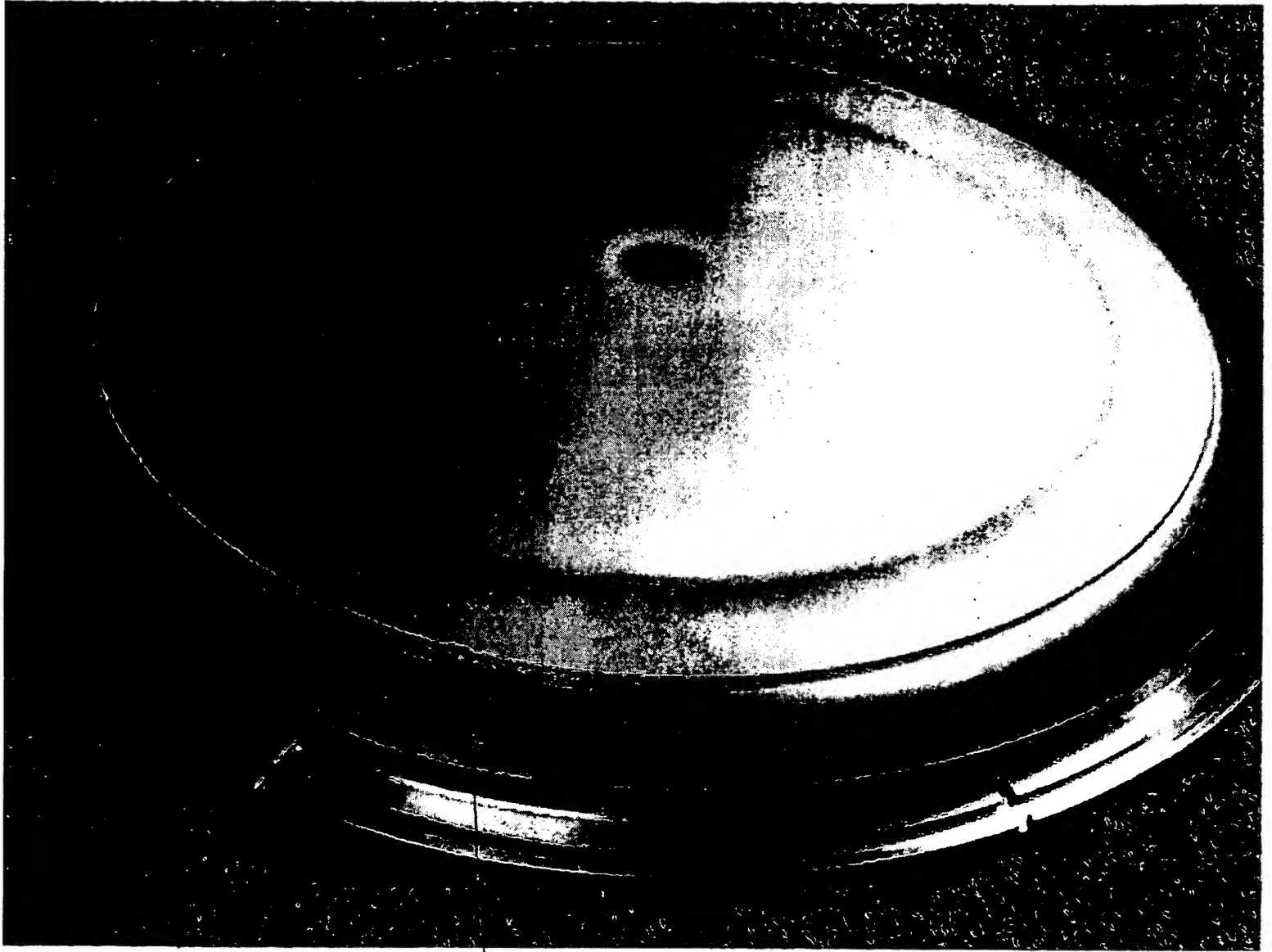


FIG. 1

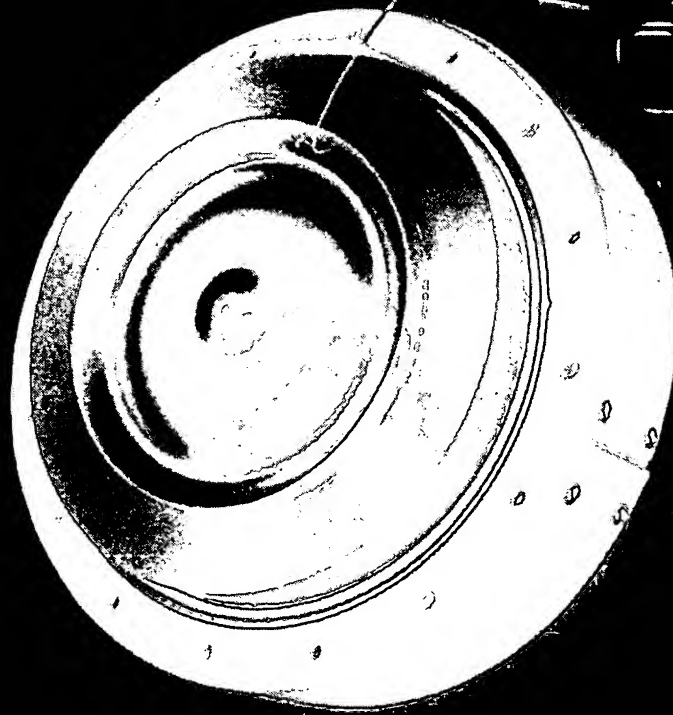


FIG. 2

Exhibit C



EROSION PATTERN



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